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Growth Mindset and Its Effect on Math Achievement

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Growth Mindset and Its Effect on Math Achievement

Jessica L. W. Baker

Thesis Submitted in Partial Fulfillment of the Requirements for the
Degree of Master of Arts in Education

California State University, Monterey Bay
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GROWTH MINDSET AND MATH ACHIEVEMENT

Growth Mindset and Its Effect on Math Achievement

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GROWTH MINDSET AND MATH ACHIEVEMENT

Abstract

Increasing mathematical skills in third graders is essential, as 55% of third graders in California tested below proficient in math on the standardized statewide test. Studies have shown that students with a growth mindset perform better in math. In this study, the hypothesis was that third-grade students who had been taught to have a growth mindset would perform better on math tests. This quantitative quasi-experimental study attempted to explicitly teach a growth mindset to third graders through ClassDojo lessons to replace a fixed mindset with a growth mindset. The sample was 42 third grade students, of which 24 students received a seven-week mindset intervention in addition to regular math instruction and 18 students received regular math instruction. Independent (control and treatment groups) and paired (pretest and posttest) sample t-tests were conducted to determine the significant difference in mathematical performance on *Eureka Math Curriculum, Grade 3 Mathematics Module 5: Fractions as Numbers on the Number Line Test* and change in mindset on *Implicit Theories of Intelligence Scale for Children*. The study only partially confirmed the hypothesis, as the treatment group did not significantly change their mindset and the control group and treatment group did not have significantly different math test scores.

Keywords: growth mindset, fixed mindset, 3rd grade, mathematics, achievement

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Growth Mindset and Its Effect on Math Achievement

Literature Review

According to the California Assessment of Student Performance and Progress (California Department of Education, 2016) results, 55% of third graders in California tested below proficient based on the Common Core State Standards (CCSS) for math. This was a five percent improvement from the previous year. Testing at or above proficiency on CCSS standards in math is critical for students, as students who have been proficient in CCSS for math in third grade are highly correlated with those students on the path to being college and career ready by the end of high school (Jones & King, 2012). Therefore, third grade teachers need to focus on ways to improve math proficiency so that third graders will be college and career ready by the end of high school.

Common Core State Standards for Mathematical Practices

The recently adopted CCSS for Mathematical Practices include new concepts for students and higher levels of critical thinking skills than previous state standards (National Governors Association Center for Best Practices, 2010). The new standards focus more on students demonstrating understanding and place less emphasis on memorization and performing procedures than previous state standards (Porter, McMaken, Hwang, & Yang, 2011). Switching to the CCSS has been a significant change for both teachers and students because the CCSS for third grade math were only 21% aligned with the previous third grade California standards for math (Porter et al., 2011).

One major addition within the CCSS has been the mathematical practice standards, which have described how students should approach math. For example, the CCSS mathematical practice standards have specified that students need the ability to persist through challenging

tasks (National Governors Association Center, 2010). In addition, students must understand the concepts behind the facts and procedures well enough to explain them to others, and they must be able to solve math problems in multiple ways. Students also need to evaluate the mathematical thinking of others, including being able to identify where someone else made a mistake (National Governors Association Center for Best Practices & Council of Chief State School Officers, 2010).

These new practices for learning math, with their focus on fully learning concepts, may have been difficult for some students because they were different from the way that students have learned in the past. Researchers have looked for ways to help students meet these rigorous CCSS standards (Paunesku et al., 2015; McLaughlin & Overturf, 2012). One way to help students approach the CCSS math standards is to teach them how to persist through difficult problems by teaching growth mindset, while replacing a fixed mindset.

Growth Mindset and Fixed Mindset

Having a fixed mindset is defined as the belief that intelligence is a fixed trait that cannot be changed (Dweck, 2000; Hochanadel & Finamore, 2015). Research, however, indicates that this type of fixed mindset negatively impacts students' ability to meet math standards (Dweck, 2010). This study further suggests that by changing the way students think about intelligence and learning can improve their math performance. Opposed to a fixed mindset, students who believe that with enough hard work they could overcome challenges have what is called a growth mindset (Dweck & Licht, 1980; Dweck, 2000; Hochanadel & Finamore, 2015).

Dweck's (2010) research has defined growth mindset as believing that you can become more intelligent through hard work. Students with a growth mindset have enjoyed challenges and have known that they must put in the effort if they want to learn something new. Even

students with low confidence in their intelligence, but having a growth mindset thrive on challenge (Dweck, 2000). Due to the results of their beliefs, students with a growth mindset have been shown to learn more than students with a fixed mindset (Dweck, 2000; Yeager et al., 2016). Dweck's (2000, 2010), explanation for this disparity is that students with a growth mindset had worked harder in school because they believed they would be more successful through asking questions and trying hard, even if they made mistakes. Moreover, people with a growth mindset believe that hard work is more important than talent (Dweck, 2010; Dweck & Licht, 1980; Hochanadel & Finamore, 2015). It follows that students who learn to use a growth mindset will be more successful with the rigorous CCSS for math.

In contrast to a growth mindset, students who have a fixed mindset believe that if someone is smart, everything is easy; however, if something is difficult, they believe that they might not be smart enough to do it (Dweck, 2010). For example, if a math task is difficult, they believe that it is because they are not good at math. In a study with junior high school students, students who scored as having a growth mindset on the *Implicit Theories of Intelligence Scale* overall improved their math grades in seventh and eighth grade (Blackwell, Trzesniewski & Dweck, 2007). In contrast the students, who scored as having a fixed mindset, overall saw their grades drop in math.

Additionally, fear of finding themselves not smart enough for a task, leads to people with a fixed mindset being prone to self-handicapping (Dweck, 2000). Self-handicapping occurs when a student withholds effort so that if they do badly on an assignment they can still think highly of their ability. When students have self-handicapped themselves, they have sabotaged long-term goals for the sake of short-term judgments. Since these students do not believe that

they can improve with effort, they do not invest their effort in an assignment that may hurt their self-image.

Fixed mindset and depression. People with a fixed mindset can be so handicapped by failure that many react the in the same manner as clinically depressed people. For example, in a study that compared a group of students with clinical depression to a group of students with a fixed mindset found that despite not suffering from depression, those with a fixed mindset responded to failure similarly to those students who were diagnosed with clinical depression (Zhao, Dweck, & Mueller, 1998 as cited in Dweck, 2000). In the study, students were given three scenarios where they imagined dealing with an important failure. The students with depression or a fixed mindset were both more likely to judge their whole intelligence based on the failure experience.

Fixed mindset and learned helplessness. Students with a fixed mindset who struggle with math may have also developed learned helplessness (i.e., student passivity or lack of motivation) and may feel discouraged or give up when a task is difficult (Dweck & Licht, 1980; Yates, 2009). Learned helplessness is prone to happen in math (Gentile & Monaco, 1986) because math is a subject where students often make mistakes in the process of learning and incorrect answers are highly visible (Dweck & Licht, 1980). Students with a fixed mindset tend to have a helpless response when faced with a challenge (Diener & Dweck, 1978; 1980). Consequently, math teachers need to teach a growth mindset to their students to lessen the chance of students having a fixed mindset.

As opposed to fixed mindset, when students with a growth mindset are faced with a challenge they want to find a way to become an expert in what they found difficult. In two studies by Diener and Dweck (1978; 1980), seventh and eighth grade students were given a

growth mindset questionnaire called *Implicit Theories of Intelligence Scale for Children* (Dweck, 2000) to determine if they had a fixed mindset or a growth mindset. Then, researchers gave the participants a series of math problems. The first eight problems were easy to solve and the next eight were too difficult to solve for someone at their grade level. After they were finished, the researchers asked each group of children (i.e., fixed or growth mindset) if they thought they would be able to solve the first eight questions again. Of the students with a fixed mindset, over one-third thought that they would not be able to solve the easy math problems again, even though they had been successful the first time. In contrast, all students with a growth mindset said that they could solve the original eight questions again (Diener & Dweck, 1978; 1980). This study demonstrates that maintaining a growth mindset can be very important when faced with difficult math problems.

Changing learned helplessness. Previous research has attempted to intervene with students experiencing learned helplessness (Dweck, 1975). In this research, teachers identified 12 students as having extreme learned helplessness. Then, six students received a treatment in which the researcher only gave assignments where they would be successful. The remaining six students were given an attribution retraining treatment, which consisted of a mixture of assignments where they would be successful and where they would fail to meet expectations. When any student failed to meet expectations, the researcher would tell the participant it was due to lack of effort. At the end of the treatment, the researchers assessed how the 12 students reacted to failure. The students who had received the success only treatment showed a severe deterioration in performance after failure; conversely, students who had received the attribution retraining maintained or improved their performance after failure.

Learning Goals and Performance Goals

Another way that teachers can change the way that students think about a task is by the way they describe it. Research demonstrates that the way that a teacher has described an assessment can affect the outcome (Dweck, 1975; Hole & Crozier, 2007). In addition to the type of assessment given (i.e., assessments in which students are always successful as compared with having mixed success), students' success can be affected by the types of goals that are set for them (i.e., learning goals as compared with performance goals; Hole & Crozier, 2007). Learning goals are defined as the desired result of learning for the sake of learning; whereas performance goals are defined as the desired result of proving you know how to do something (Hole & Crozier, 2007).

In a 2007 study, Hole and Crozier investigated how giving a learning goal versus giving a performance goal affected the outcome of an assessment. In the study, half of the children were given learning goal instructions stating that they were going to solve a puzzle to learn and get better at solving puzzles. The other half of the students were given performance goal instructions stating that they were solving a puzzle to show how smart they were (Hole & Crozier, 2007). The researchers found that the students who were given the learning goal instructions tried harder and did not give up. However, the students who were given the performance goal instructions, for the most part, gave up during the second puzzle. This study showed that teachers have the power to help their students just by the way they describe an assessment.

People who are told that strategies are more important than abilities (an essential element of a growth mindset) when completing a task tend to not give up after meeting failure. In a study by Anderson and Jennings (1980), adult subjects were given a task to persuade a person by

phone. Similarly to the Hole & Crozier (2007) study, before the first attempt, some subjects were told that persuading someone was a matter of ability and other subjects were told that persuading someone depended on having the right strategy. All subjects failed to persuade the first person. Participants who were told that strategies were more important than abilities were more likely to think that they would succeed at the task in the future. The results of this study would likely apply to all people, including third graders.

Teaching Growth Mindset

As with creating learning goals rather than performance goals, studies have shown that you can teach students to have a growth mindset rather than a fixed mindset (Blackwell et al., 2007; Esparza, Shumow, & Schmidt, 2014; Paunesku et al., 2015; Schmidt, Shumow, & Kackar-Cam, 2017). In two different studies with seventh grade students (Blackwell, et al., 2007; Esparza et al., 2014), students in the treatment group received growth mindset lessons that included information about how the brain worked, how students could improve their intelligence, and that explained that learning makes you smarter. After the interventions in these two studies, students in the treatment group in each study believed more strongly in a growth mindset after the intervention than before, whereas the students in the control group did not change their mindset at all. The studies suggest that teachers can change students' mindsets through growth mindset lessons. Furthermore, when students do not receive instruction in growth mindset techniques, they demonstrate decline in self-reported perceived control, skill, interest, and learning (Schmidt et al., 2017); however, students who participate in growth mindset instruction are more likely to report an increase in self-reported perceived control and interest (Schmidt et al., 2017) and to earn satisfactory grades (i.e., As, Bs, or Cs) in core academic classes after the intervention when compared to control group students (Paunesku et al., 2015).

Research into growth mindset interventions reveals that for students to succeed, educators need to teach students to value learning over appearing to be smart (Dweck, 2000). Students should learn to love challenges and effort and to view errors as a path to proficiency in a concept or skill. The aforementioned studies have provided evidence that teachers can explicitly teach their students how to have a growth mindset and that when students have received a mindset intervention they improve their performance in school. Additionally, mindset interventions also improve students' feeling of interest and control in the classroom (Schmidt et al., 2017). Furthermore, mindset interventions help students enjoy challenges, persist when faced with problems, and ask questions when they do not understand (Dweck, 2000; 2010). All students will face difficulties in school at some point, however with a growth mindset, students can overcome difficulties and become lifelong learners. It follows that teaching third grade students about having a growth mindset will help them meet CCSS for math in third grade and will also help them be successful throughout their schooling and later in their careers.

Purpose

Numerous studies have been conducted which investigate how changing people's mindset can change their achievement and help them face challenging situations (Anderson & Jennings, 1980; Blackwell et al., 2007; Esparza et al., 2014; Paunesku et al., 2015; Schmidt et al., 2017; Yeager et al., 2016), but few studies have been conducted in elementary schools. This would be equally valuable given the importance of performance throughout elementary school and the challenges third grade students have faced with the recently adopted CCSS for math (National Governors Association Center for Best Practices, 2010). If the mindset treatment can be effective with third graders, teachers would be able to increase students' ability to work

through the challenges of learning math concepts. The purpose of this study is to discover if learning about growth mindset will result in increased math scores for third grade students.

Methods

Research Question

Does teaching third grade students explicitly how to have a growth mindset improve their math test scores?

Hypothesis

Yeager and colleagues, (2016) created a growth mindset treatment study for ninth graders in which the ninth graders who received the growth mindset treatment saw a significant improvement in their grades when compared to the control group. Based on this research, it was predicted that third grade students who have been taught to have a growth mindset would perform better on math tests.

Research Design

This study was a quantitative quasi-experimental design using a pretest and posttest. The group was the researcher's class and the control group was another third grade class at the same school. All participants were given a pretest and posttest consisting of a fractions math test from Eureka Math curriculum (Center & Department of Mathematics at Louisiana State University, 2016) and a growth mindset questionnaire *Implicit Theories of Intelligence Scale for Children* (Dweck, 2000).

Independent variable. The independent variable in this study was a seven-week growth mindset intervention.

Dependent variable. The dependent variable in this study was the students' math scores on Eureka math tests (Center & Department of Mathematics at Louisiana State University, 2016) and the *Implicit Theories of Intelligence Scale for Children* (Dweck, 2000).

Setting and Participants

The study took place at an elementary school in a California central coast school district, made up of 412 students. The school consisted of 229 boys (56%) and 183 girls (44%), 92 of which were classified as English Learners (22%). There were 40 students who received resource specialist services for math and English language arts (10%) and 262 students were classified as socioeconomically disadvantaged (64%). The school included 188 students who were Hispanic (46%), 18 who were two or more races (4%), 33 who were Filipino (8%), 84 who were white (20%), 41 who were Asian (10%), 17 who were Pacific Islander (8%), and 29 who were African American (7%).

Sample. The sample was a convenience sample of 58 students from two separate third grade classrooms of similar demographics within the same elementary school. The researcher's class was the treatment group because the researcher has the background knowledge from research to implement the mindset intervention. The two teachers taught the same math curriculum in both classrooms.

Treatment group. The treatment group included 29 students. There were 18 boys (67%) and 9 girls (33%). Six of the students were classified as English Learners (22%) and two students received resource specialist services for math and English language arts (7%). In addition, 15 students were classified as socioeconomically disadvantaged (56%). The class was made up of 15 students who were Hispanic (56%), four who were two or more races (14.81%),

three who were Filipino (11%), three who were white (11%), two who were Asian (7%), one who was Pacific Islander (4%), and one who was African American (4%).

Control group. The control group had 29 students. There were 17 boys (63%) and 10 girls (37%). Six of the students were classified as English Learners (22%) and none of the students received resource specialist services for math and English language arts. In addition, 20 students were classified as socioeconomically disadvantaged (74%). The class consisted of 14 students who were Hispanic (52%), one who was Filipino (4%), six who were white (22%), three who were Asian (11%), two who were Pacific Islander (7%), and one who was African American (4%).

Measures

There were two measures used in this study: the fractions math test from the *Eureka Math Grade 3 Module 5* curriculum (Center & Department of Mathematics at Louisiana State University, 2016) and the *Implicit Theories of Intelligence Scale for Children* (Dweck, 2000).

Math test. The Eureka Math test was made up of five questions that were graded on a rubric of one to four and students could score a maximum of sixteen points on the test (see Appendix A). If the student answered all parts of the question with complete accuracy, they got a score of four. On the other hand, if a student showed evidence of some mathematical reasoning with a correct answer or evidence of solid reasoning with an incorrect answer, they received a score of three points. In contrast, if a student showed proof of some mathematical reasoning without a correct answer, they were given a score of two. However, if a student attempted to answer the problem but did not show evidence of understanding the problem, they received a score of one (see Appendix B).

Growth mindset questionnaire. *The Implicit Theories of Intelligence Scale for Children* (Dweck, 2000) was made up of six statements that measured growth or fixed mindset. The participants rated the statements on a 6-point Likert scale (i.e., 1 = Strongly Agree; 6 = Strongly Disagree). Examples of the statements included, “You can have a certain amount of intelligence, and you really can’t do much to change it,” and “You can always greatly change how intelligent you are” (see Appendix C). Students were given 15 minutes to complete the questionnaire. The fixed mindset statements were scored so that a high score meant a high growth mindset. On the other hand, the growth mindset statements were reverse scored so that a high score meant a high growth mindset.

Validity. The pretest and posttest were from *Eureka Math Curriculum, Grade 3 Mathematics Module 5: Fractions as Numbers on the Number Line* (Center & Department of Mathematics at Louisiana State University, 2016). The test was used to measure the students’ ability to understand fractions. Experts in the field who wrote the math test have established the validity and the test is part of the school district’s adopted curriculum.

In a study with eighth graders, researchers focused on what kind of tasks participants chose and how that correlated with their growth or fixed mindset (Dweck & Leggett, 1988; Leggett, 1985, as cited in Dweck, 2000). The researchers used the *Implicit Theories of Intelligence Scale for Children* to determine whether the participants had a growth mindset or a fixed mindset and to what extent. Then, the researchers offered the participants an array of tasks to undertake. One task had a performance goal that was easy, one had a performance goal that was more difficult, but a participant could complete without making mistakes, and another task had a learning goal that was hard, new, and different, but the participant was likely to learn something from completing the task. Of the eighth grade students who had a score that indicated

a fixed mindset, 80% chose a performance goal. Conversely, of the eighth grade students who had a score that showed a growth mindset, over 60% chose the learning goal task. This outcome showed the predictive validity of the *Implicit Theories of Intelligence Scale for Children*.

Reliability. The *Eureka Math Curriculum, Grade 3 Mathematics Module 5: Fractions as Numbers on the Number Line* (Center & Department of Mathematics at Louisiana State University, 2016) test was made up of five questions. The researcher and the other third grade teacher scored the math tests together and calibrated their scoring on a rubric provided by the Eureka Math curriculum with possible scores of one to four. To ensure at least 80% reliability, the researcher and the other third grade teacher calibrated scoring at least 20% of the tests. *The Implicit Theories of Intelligence Scale for Children* (Dweck, 2000) had a high internal consistency (0.94 to 0.98) using Cronbach's Alpha values (Dweck, Chiu, & Hong, 1995) and high 2-week test-retest consistency ($r = 0.80$).

Intervention

Once a week for seven weeks, students in the treatment group were taught growth mindset through seven lessons that did not take away time from math instruction. The lessons included five growth mindset videos with discussion questions and two growth mindset activities created by ClassDojo and Stanford's Project for Education Research that Scales (PERTS) research center (2016). Stanford's PERTS research center has been an organization whose goal is to translate research findings into practical solutions for educators to implement in their classroom. Boaler and Dweck, who have done extensive research on the impact of growth mindset on student learning, are among collaborators at Stanford's PERTS research center (2016).

The first five lessons involved watching and discussing a video and each took fifteen minutes or less. The two to four minute videos followed characters learning about growth mindset at school, and each video had three to four whole class discussion questions that students could use to process the video. The final two lessons consisted of two activities, which allowed students to apply their learning from the previous five weeks. During week six, students anonymously wrote down a time they made a mistake, crumpled it up, and threw it across the room. Students read each other's mistakes to realize that everyone makes mistakes. During week seven, students worked together to complete a challenging puzzle. By completing the difficult puzzle in groups, they were applying their knowledge of working hard and persisting in face of a challenge.

Procedures

Students participated in a seven-week experimental study that allowed the researcher to use the curriculum's math tests as the pretest and posttest. The participants in control and treatment groups were given a math test and the mindset questionnaire (Dweck, 2000) during the first week, followed by seven weeks of math instruction for both groups and seven weeks of mindset intervention for the treatment group. *Eureka Math Curriculum, Grade 3 Mathematics Module 5: Fractions as Numbers on the Number Line* (Center & Department of Mathematics at Louisiana State University, 2016) module lasted for seven weeks; therefore, the growth mindset intervention lasted the same length.

The researcher explicitly taught growth mindset to the treatment group through a series of seven lessons, over the course of seven weeks after the initial test. The treatment group received growth mindset lessons in addition to their regular math lessons. While the intervention group was receiving their intervention, the students in the control group were doing their usual

classroom meeting during this time. Classroom meetings gave students a chance to build community and talk about ways to solve social problems. After the seventh week, all students took the fractions math test (Center & Department of Mathematics at Louisiana State University, 2016) and the mindset questionnaire (Dweck, 2000) again. The researcher evaluated whether the mindset score in the treatment group had improved and if the math test scores were significantly different between the treatment group and control group.

Data collection. Data was collected at the beginning and end of the study and no data was collected during the intervention. The fractions math test (Center & Department of Mathematics at Louisiana State University, 2016) and the mindset questionnaire (Dweck, 2000) were given at the beginning of week one. All participants received seven weeks of third grade fractions instruction; in addition, the treatment group received seven weeks of growth mindset instruction. After week seven, all students were given the posttests, which were the same as the pretests.

Fidelity. Both teachers agreed to teach the same math lessons on the same days with 100% fidelity. The academic coach and another teacher walked through both classrooms to make sure that only the treatment group was learning about a growth mindset through the ClassDojo videos (see Appendix D).

Ethical Considerations

Confidentiality was maintained by recording student test scores without student names. The intervention did not cause any harm, and was a positive learning experience. The control group was not harmed because they continued their instruction as usual. If the treatment group significantly increased their math scores, it would have been unethical to withhold this

intervention from the control group. If the intervention was successful with the experimental group, the control group would have been allowed to begin the intervention after the study.

Validity threats. The control group and the treatment group were taught by two different teachers with varying levels of experience teaching math to third graders. To minimize the impact this would have on the study, the third grade teachers collaborated about math instruction. Student's abilities to learn fractions may have also varied, which might have impacted the assessment results. Data from all 29 students was collected from each group to minimize the effects of any outlier students in the class. The researcher might have been biased because she used a convenience sample of her own class.

Data Analyses

All data were entered into the Statistical Package for the Social Sciences® (SPSS®) for Windows, version 24.0.0 (SPSS, 2016). No names or identifying information were included in the data analysis. Before analyses were conducted all data were cleaned to ensure no outliers were present (Dimitrov, 2012). Twelve participants were removed from the data file due to missing the pretest or posttest. After cleaning the data, the final sample size was 24 for the treatment group and 18 for the control group.

Independent (control and treatment groups) and paired (pretest and posttest) sample t-tests were conducted to determine the significant difference in mathematical performance on *Eureka Math Curriculum, Grade 3 Mathematics Module 5: Fractions as Numbers on the Number Line Test* and change in mindset on *Implicit Theories of Intelligence Scale for Children*. Further, before interpreting the analytical output, Levene's Homogeneity of Variance was examined to see if the assumption of equivalence had been violated (i.e., the variances were

equal across groups), data were interpreted for the assumption of equivalence; however, if the variances were not equal across groups the corrected output was used for interpretation.

Results

Results for this study were organized by measure in order to increase clarity.

Mindset Questionnaire

Two independent samples t-tests were conducted on the whole sample ($n = 42$) for both the pre and post assessment scores. Results for the pretest were: Levene's Homogeneity of Variance was not violated ($p > .05$), meaning the variance between groups was not statistically different and no correction was needed, and the t-test showed nonsignificant differences between the mean scores on the pretests between the two groups $t(47) = -1.79, p > 0.05$. This shows that there was not a significant difference between the means on the pretest for the treatment and control groups and the two groups were comparable (see Table 1). Results for the posttest were: Levene's Homogeneity of Variance was not violated ($p > .05$), meaning the variance between groups was not statistically different and no correction was needed, and the t-test showed nonsignificant differences between the mean scores on the posttests between the two groups $t(39) = 1.10, p > 0.05$. This means that the difference between the posttests of the treatment and control groups were not statistically significant (see Table 1).

Table 1

Results of Independent Samples T-Tests for Growth Mindset

	Mean	SD
Pretest		
Treatment	3.93	1.07
Control	4.42	0.83
Posttest		
Treatment	4.38	1.03
Control	4.02	1.09

Note. SD = Standard Deviation.

After determining the differences between pre and post assessment scores between groups, two paired t-tests were run for both groups (i.e., treatment and control) to determine if participants mean scores from pre to post were significantly different within each group (see Table 2). Results for each group were as follows: treatment group, $t(22) = -1.59, p > .05$; control group, $t(17) = 0.97, p < 0.05$, meaning that the treatment group saw no statistical difference in mean scores from pre to post test; whereas the control group did see a significant difference in mean score. Although not statistically significant, the treatment group did improve their scores by 0.27 points; however, the control group saw a statistically significant decrease in their scores (-0.29 points). Therefore, although the hypothesis that the intervention would improve the mindset for the treatment group was rejected, the increase in treatment group scores and the decrease in control group scores suggest the intervention had some influence on students.

Table 2

Results of Paired T-Tests for Growth Mindset

	Mean	SD
Treatment Group		
Pretest	4.01	1.03
Posttest	4.38	1.03
Control Group		
Pretest	4.30	0.20
Posttest	4.01	0.26

Note. SD = Standard Deviation.

Fractions Math Test

Two independent samples t-tests were conducted on the whole sample ($n = 42$) for both the pre and post assessment scores. Results for the pretest were: Levene's Homogeneity of Variance was violated ($p < .05$) meaning the variance between groups was statistically different and the second line of data were used. The t-test showed non-significant difference between the

mean scores of the two groups $t(34.23) = -0.01, p > 0.05$. This indicates that both groups were very similar in mean scores and were therefore comparable. Further, the mean scores for the treatment and control groups were exactly the same on the pretest, but the standard deviation was different (see Table 3).

Results for the post-test were: Levene's Homogeneity of Variance was not violated ($p > .05$), meaning the variance between groups was not significantly statistically different and no correction was needed, and the t-test showed non-significant differences between the mean scores on the posttests between the two groups $t(47) = 0.64, p > 0.05$. The mean and standard deviation were not statistically significant (see Table 3) meaning that the difference between the two groups on the posttest was not meaningfully different.

Table 3

Results of Independent Samples T-Tests for Math Test

	Mean	SD
Pretest		
Treatment	3.88	1.87
Control	3.88	0.97
Posttest		
Treatment	7.08	3.83
Control	6.44	3.14

Note. SD = Standard Deviation.

After determining the differences between pre and post assessment scores between groups, two paired t-tests were run for both groups (i.e., treatment and control) to determine if participants mean scores from pre to post were significantly different within each group (see Table 4). Results for each group were as follows: treatment group, $t(23) = -4.05, p < .001$; control group, $t(24) = -3.72, p < 0.01$. The mean of the treatment and control groups improved statistically significantly between the pre and post tests. Additionally, the negative t-value for

each group indicates an increase in scores from pre to post assessment. This means that everyone learned something about fractions during the study, which partially supported the hypothesis that the intervention would improve math scores. Further, the treatment group did have a higher average score (meaning they learned more than the control group as their means were equivalent to start), but the hypothesis was not fully supported since there was not a significant difference in the post scores between the treatment and control groups.

Table 4

Results of Paired T-Tests for Math Test

	Mean	SD
Treatment Group		
Pretest	3.88	1.87
Posttest	7.08	0.97
Control Group		
Pretest	3.88	3.83
Posttest	6.44	3.14

Note. SD = Standard Deviation.

Discussion

The purpose of this study was to find out if third grade students who have been taught to have a growth mindset would perform better on math tests. The sample was 42 students of which 24 students received the seven-week mindset intervention in addition to regular math instruction and 18 students received just their regular math instruction. The two pre and post tests that the treatment and control group took included a growth mindset questionnaire and a fractions math test.

This study had a two-part hypothesis: first, that the treatment group would change their mindset by doing ClassDojo lessons, second, that student's growth mindset would improve math

scores. The first part of the hypothesis was partially accepted because the treatment group's mindset increased, but this was not a statistically significant change. The second part of the hypothesis was also partially accepted as the treatment group statistically increased their math scores from pre to post; however, their growth was not statistically higher than the control group. Furthermore, the treatment group did not have significantly higher posttest math test scores than the control group. Although the treatment group scored 0.36 points higher on the growth mindset questionnaire and 0.64 points higher on the math test than the control group, the difference between scores was not statistically significant. Thus, growth mindset videos were not effective enough to change growth mindset statistically significantly or to change math achievement significantly. However, the treatment group did score higher than the control group on both the posttests even though the difference was not statistically significant.

During this study, the treatment group improved their scores for the mindset questionnaire by 0.27 points, whereas the control group saw a statistically significant decrease in their scores (-0.29 points). This suggests that the intervention had some effect on participants' mindset. Also, this means that the control group was slightly less likely to think that they could achieve anything through hard work compared to before. This points to variation in mindset questionnaire scoring within the control group the source of which should be further investigated and quantified. Although the results were not statistically significant, they did show small differences between the two groups. There are many possible explanations for the results of this study.

Growth Mindset Limitations and Future Research

There are several limitations to the current study that should be addressed by researchers in future studies. The mindset questionnaire (Dweck, 2000) did not show significant change

from pretest to posttest or between the control group and treatment group. The questionnaire may have been confusing for the third grade students because it was made for students fourth grade and older. This questionnaire asked them if they agreed with three growth mindset statements and three fixed mindset statements. Many students marked that they agreed with all the statements, even though half of the statements were the opposite mindset. Third graders may have been too young to distinguish the meaning of the statements or may have rushed through the questionnaire to finish. In the future, studies may want to design a questionnaire aimed at third graders with clear child friendly language.

Age. The previously cited studies (Anderson & Jennings, 1980; Blackwell et al., 2007; Esparza et al., 2014; Paunesku et al., 2015; Schmidt et al., 2017; Yeager et al., 2016) successfully taught growth mindset to students in middle school, high school, and college, not students in third grade. Therefore, the age of the students in this study may have had an influence on the outcomes of the mindset survey. Future studies should create a new survey for younger students, perhaps using pictures to go along with the Likert scale.

Sample size. Furthermore, the sample size was larger in the studies by Blackwell and colleagues (2007), Esparza and colleagues (2014), Paunesku and colleagues (2015), Schmidt and colleagues (2017), and Yeager and colleagues (2016) and this study would have benefited from a larger sample size to offset the impact of outliers and students that did not take both the pretest and the posttest.

Time. This study took a similar length of time as other studies but used shorter lessons. Studies by Esparza and colleagues (2014), Blackwell and colleagues (2007), and Schmidt and colleagues (2017) consisted of one lesson a week for six weeks, whereas this study consisted of one lesson a week for seven weeks. Blackwell and colleagues' (2007) study had weekly lessons

that were 25 minutes and Esparza and colleagues' (2007) and Schmidt and colleagues' (2017) studies had lessons once a week for 50 minutes. In contrast, this study's lessons were 10 to 15 minutes long. Schmidt and colleagues' study also included brief homework assignments or additional in class activities on other days. This study could have benefited from longer lessons similar to the studies by Blackwell and colleagues (2007), Esparza and colleagues (2014) and Schmidt and colleagues (2017). Although, in the studies by Paunesku and colleagues (2015) and Schmidt and colleagues (2017), students received the treatment condition for only two class periods. So, the case may be that the content is more important than the length of time spend on the treatment. Future studies would likely benefit from increasing the time spent on growth mindset lessons.

Type of lessons. The case may be that the treatment of ClassDojo activities used in this study were simply not effective for third graders. In Blackwell and colleagues' (2007) study students learned through readings, activities, and discussions. This study only used ClassDojo videos and discussions. This study may have benefited from having readings in addition to the videos and activities and may have also benefited from having longer lessons. In the studies by Esparza and colleagues (2007), Schmidt and colleagues (2017), and Yeager and colleagues (2016), participants used an online computer program, which could have been more engaging for third graders.

Educators may need to take a different approach with third grade students. Two of the previously mentioned studies did not explicitly teach a growth mindset but instead suggested to the participants in the treatment group that their failure was due to their choice in strategy (Anderson & Jennings, 1980) or lack of effort (Dweck, 1975), which are both part of having a growth mindset. In both studies, participants that were part of the treatment group were more

likely to predict that they would be successful in the future. The study by Dweck was a small sample of students that included third grade students (1975). Third graders may need adults to remind students of growth mindset strategies, including changing the strategy or putting forth more effort, when the student fails. Students that age may need adults to explicitly make that connection for them instead of just teaching them about the way a growth mindset works like the ClassDojo videos attempted to do. Future studies may benefit from using reading and writing activities and teaching growth mindset throughout the day rather than just ten to fifteen minutes a week.

Math Achievement Limitations and Future Research

There are several limitations to the current study that should be addressed by researchers in future studies. Although both groups showed significant growth from pretest to posttest in scores from the fractions math test (Center & Department of Mathematics at Louisiana State University, 2016), the scores for the treatment group were not significantly different from the math test scores for the control group. This is not surprising considering that there was not a significant improvement in growth mindset. All students learned math, but teaching growth mindset did not affect the scores in a statistically significant way. Paunesku and colleagues' (2015) study with high school students found that students who received growth mindset lessons were more likely to earn satisfactory grades (i.e., As, Bs, or Cs) in core academic classes after the intervention when compared to control group students. This study may have been affected by the age of the students. Furthermore, even though the pretest and posttest both showed significant growth, the mean score was still below proficient, meaning that math scores are still a concern at this elementary school. The math scores in third grade are still a concern because students who have been proficient in CCSS for math in third grade are considered to be those

students on the path to being college and career ready by the end of high school (Jones & King, 2012).

Overall Limitations

Limitations to this study include that the sample was a convenience sample; the researcher used her class and another class at the same school. This study would have benefited from a larger sample size. Also, many students had to be removed from the data file due to missing the pretest or posttest, which made the sample even smaller. The time of day that students received the intervention may have also affected the study because the intervention was given right before lunch and students may have been tired from learning for the past four hours or distracted by hunger. This study may have benefited from qualitative interviews with the participants because the researcher may have gotten a more accurate picture of students' mindset and why the treatment group did not significantly change their mindset despite the intervention.

Future Studies

This study demonstrates the need for future studies on growth mindset to focus on students in the younger grades (i.e., grade 3 and below). Future studies should look for a better mindset questionnaire for third grade students and a different way to teach students to have a growth mindset. Many studies affirmed that changing people's mindset to a growth mindset can improve their achievement and help them face challenging situations (Anderson & Jennings, 1980; Blackwell et al., 2007; Esparza et al., 2014; Paunesku et al., 2015; Schmidt et al., 2017; Yeager et al., 2016). If changing a mindset in older students can improve their achievement, there may be a way to effectively improve the mindset of third grade students.

Future studies should focus on the best way to teach a growth mindset to students in third grade to improve their academic achievement. Additionally, more studies in this area are

essential because students who have been proficient in CCSS for math in third grade are considered to be those students on the path to being college and career ready by the end of high school (Jones & King, 2012). Solutions still need to be found to help students succeed in their mathematics performance by replacing a fixed mindset with a growth mindset.

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Appendix A

Eureka Math End of Module Task

1. Jerry put 7 equally spaced hooks on a straight wire so students could hang up their coats. The whole length is from the first hook to the last hook.

- a. On the picture below, label the fraction of the wire's length where each hook is located.

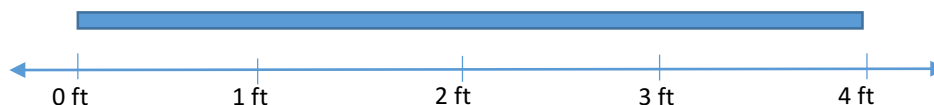


- b. At what fraction is Betsy's coat if she hangs it at the halfway point?
- c. Write a fraction that is equivalent to your answer for Part (b).
2. Jerry used the picture below to show his son how to find a fraction equal to. Explain what Jerry might have said and done using words, pictures, and numbers.



3. Jerry and his son have the exact same granola bars. Jerry has eaten $\frac{1}{2}$ of his granola bar. His son has eaten $\frac{1}{3}$ of his own granola bar. Who has eaten more? Explain your answer using words, pictures, and numbers.
4. Jerry has a fruit roll that is 4 feet long.

- a. Label the number line to show how Jerry might cut his fruit roll into pieces of a foot long. Label every fraction on the number line, including renaming the wholes.



- b. Jerry cut his fruit roll into pieces that are of a foot long. Jerry and his 2 sons each eat one piece. What fraction of the whole fruit roll is eaten? Explain your answer using words, pictures, and numbers.
- c. Jerry's son says that $\frac{1}{3}$ is the same as $\frac{2}{6}$ s. Do you agree? Why or why not? Use words, pictures, and numbers to explain your answer.

Appendix B

End of Module Assessment Task Rubric.

A Progression Toward Mastery				
Assessment Task Item and Standards Assessed	STEP 1 Little evidence of reasoning without a correct answer. (1 Point)	STEP 2 Evidence of some reasoning without a correct answer. (2 Points)	STEP 3 Evidence of some reasoning with a correct answer or evidence of solid reasoning with an incorrect answer. (3 Points)	STEP 4 Evidence of solid reasoning with a correct answer. (4 Points)
1 3.NF.2a 3.NF.3a	The student is unable to label the number line.	The student labels the number line but thinks is because of the 2 in the numerator. Clear flaws in understanding are visible.	The student shows good reasoning and makes one small mistake, such as failing to correctly label or failing to identify the fraction equal to .	The student correctly: Labels the number line with sixths. Identifies as the halfway point for Betsy's coat. Writes any fraction equivalent to , such as .
2 3.NF.3b 3.G.2 3.NF.1	The student does not demonstrate understanding.	The student may partition the strip correctly but does not give a clear explanation.	The student's explanation lacks clarity, but the drawing shows understanding. The strip is labeled.	The student uses words, pictures, and numbers to: Explain how Jerry would make smaller equal parts. Name a fraction equal to , such as , , or .
3 3.NF.3d 3.NF.1	The student does not demonstrate understanding of the meaning of the question and does not produce meaningful work.	The student may say that the son has eaten more but does show some understanding. This is possibly evidenced by two fraction strips correctly partitioned but perhaps not the same size.	The student shows that Jerry has eaten more and correctly compares to ; the explanation includes some reasoning.	The student clearly explains: Jerry has eaten more of his granola bar. > . is greater than because the units are larger.

A Progression Toward Mastery				
4 3.NF.2a, b 3.NF.3a–d 3.NF.1	The student does not demonstrate understanding of the meaning of the question and does not produce meaningful work.	The student completes part of the problem correctly but fails to draw accurate models or explain reasoning.	The student completes Parts (a), (b), and (c) correctly; the explanation includes some reasoning.	The student correctly: Shows all of the fractions from up to numerically, including renaming the wholes. Explains or of the whole roll was eaten with an accurate model in Part (b). Uses words, pictures, and numbers to explain that is equal to in Part (c).

Appendix C**Implicit Theories of Intelligence Scale for Children – Self Form**

Read each sentence below and then circle the one number that shows how much you agree with it. There are no right or wrong answers.

1. You have a certain about of intelligence, and you really can't do much to change it.

1	2	3	4	5	6
Strongly	Agree	Mostly	Mostly	Disagree	Strongly
Agree		Agree	Disagree		Disagree

2. Your intelligence is something about you that you can't change very much.

1	2	3	4	5	6
Strongly	Agree	Mostly	Mostly	Disagree	Strongly
Agree		Agree	Disagree		Disagree

3. You can learn new things, but you can't really change your basic intelligence.

1	2	3	4	5	6
Strongly	Agree	Mostly	Mostly	Disagree	Strongly
Agree		Agree	Disagree		Disagree

4. No matter who you are, you can change your intelligence a lot.

1	2	3	4	5	6
Strongly	Agree	Mostly	Mostly	Disagree	Strongly
Agree		Agree	Disagree		Disagree

5. You can always greatly change how intelligent you are.

1	2	3	4	5	6
Strongly	Agree	Mostly	Mostly	Disagree	Strongly
Agree		Agree	Disagree		Disagree

6. No matter how much intelligence you have, you can always change it quite a bit.

1	2	3	4	5	6
Strongly	Agree	Mostly	Mostly	Disagree	Strongly
Agree		Agree	Disagree		Disagree

Appendix D

Fidelity to Intervention Observation Sheet

Date	Treatment/Control	Signature/Initials
2/23/17	Treatment + Control	Ch...
2/27/17	Treatment + Control	Ch...
3/7/17	Treatment + Control	Wendy Williamson
3/14/17	Treatment + Control	Wendy Williamson